

TRMM-LIS Lightning Climatology and Time Series

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Acknowledgements:

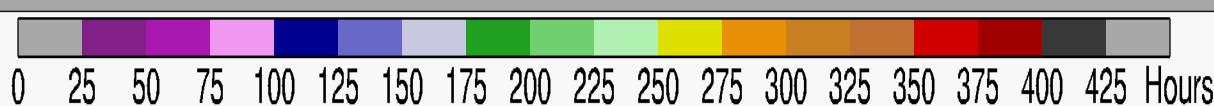
- **LIS/OTD Science Teams, support from NASA TRMM**
- **GHRC- hosting the LIS data**

Hours of Sampling By LIS and OTD, 1995-2013

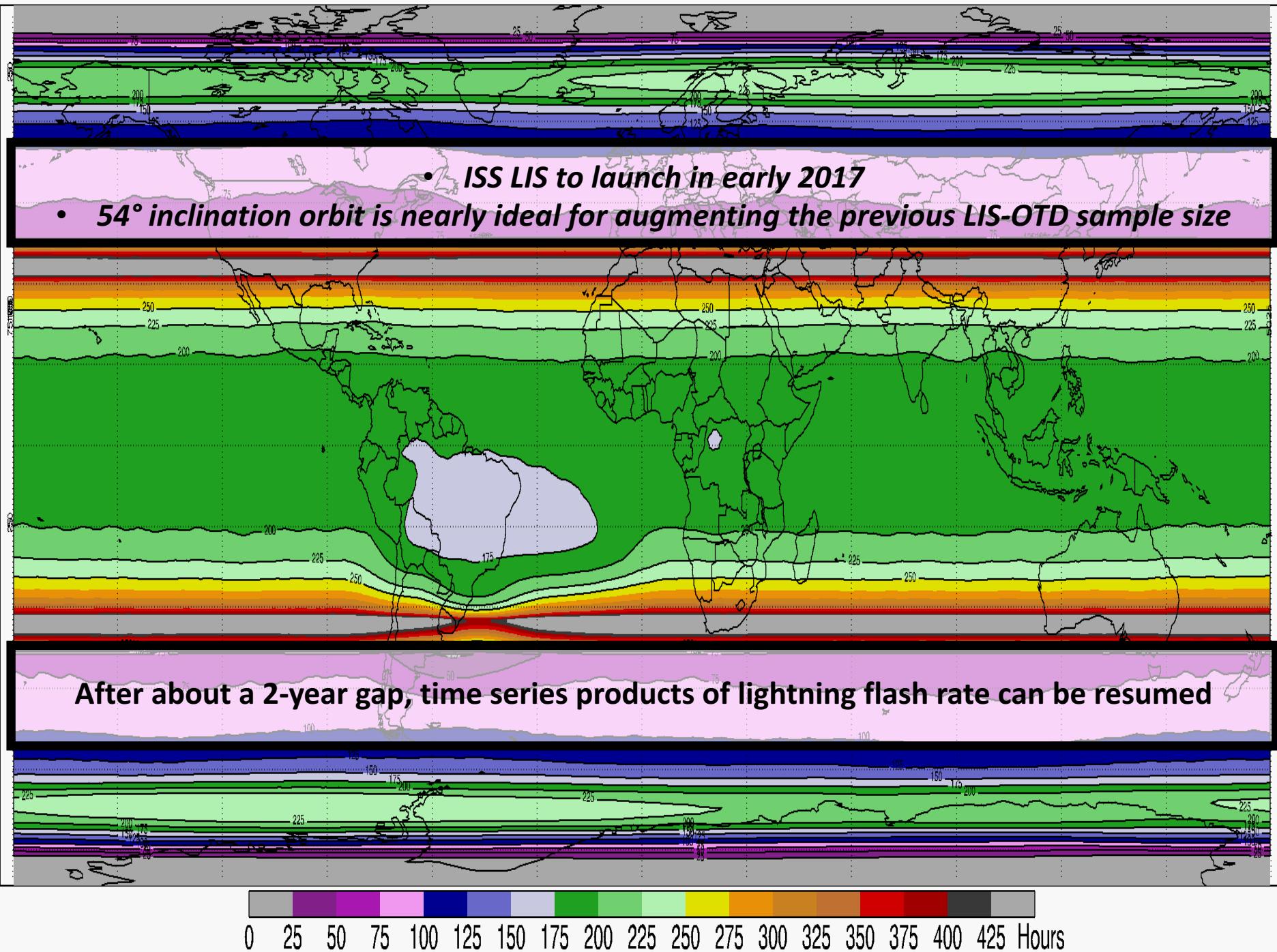
Least Sampling In Mid-Latitudes

- Total sampling equivalent to 1-3 weeks of continuous observation, distributed over the 18 year period
- ~125 hours LIS, ~200 hours combined sampling in the tropics
- ~500 hours near top of LIS orbit (35°)
- ~50 hours from OTD just north / south of LIS domain
- ~240 hours near top of OTD orbit (75°)

Least Sampling In Mid-Latitudes

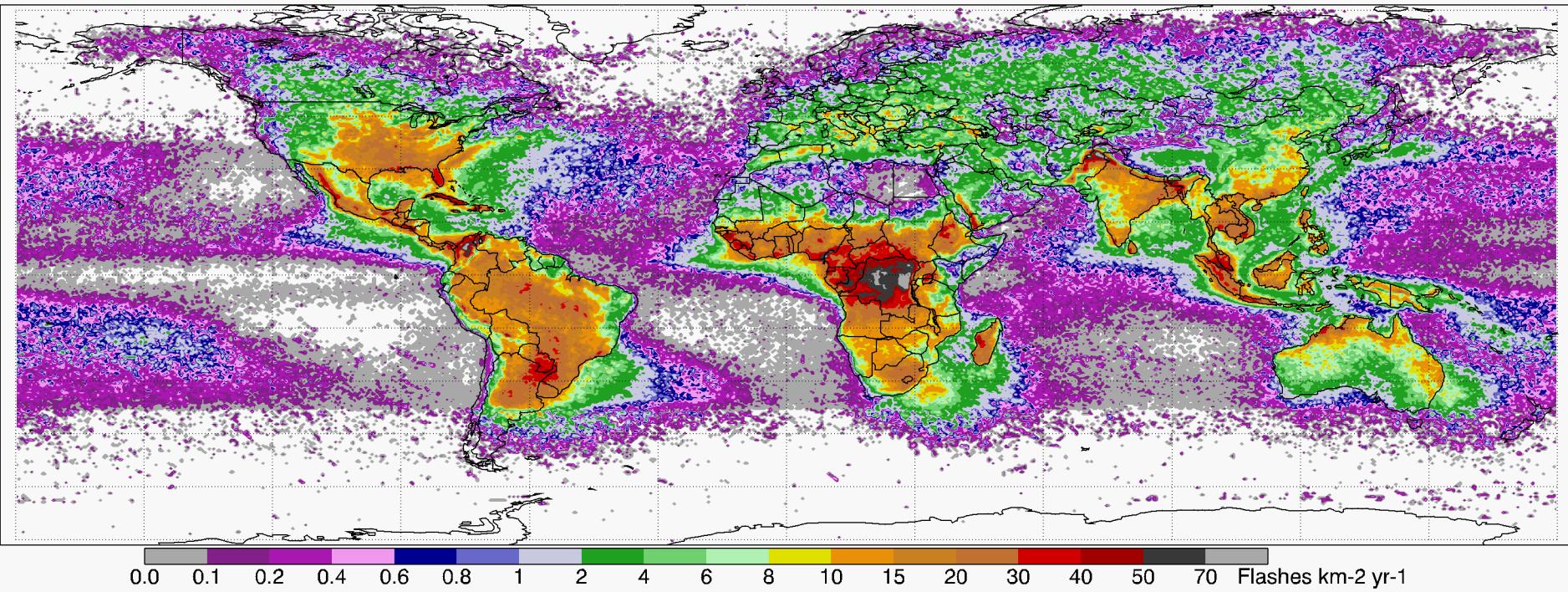


Hours of Sampling By LIS and OTD, 1995-2013



Annual Mean Total Lightning Flash Rate from TRMM-LIS and OTD (1995-2014)

HRFC_COM_FR



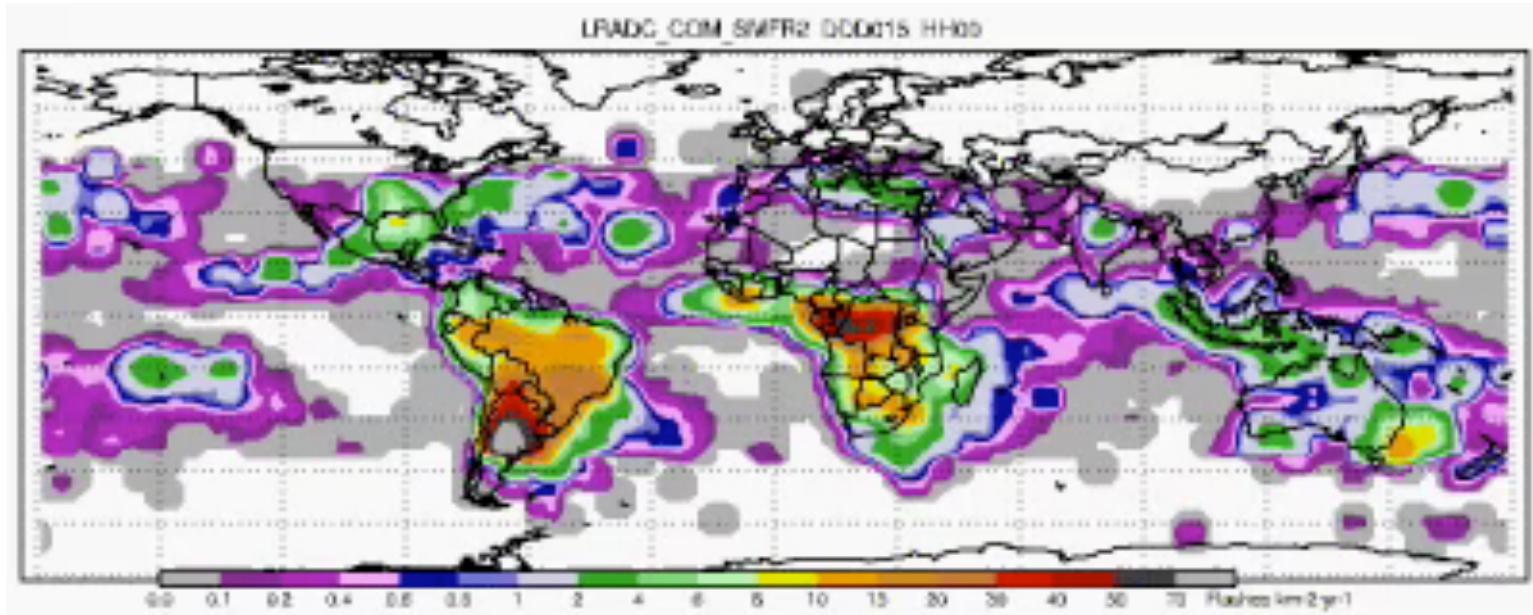
From a simple counting experiment, the total number of flashes observed divided by the total observation duration for each 0.5° grid box

Annual Cycle, Diurnal Cycle, Inter-Annual Variability

As the data volume grows large, we can examine finer details and get robust results:

- Annual Cycle
- Diurnal Cycle
- Diurnal Cycle, as it varies through the year
- Inter-Annual Variability

Mean Annual and Diurnal Cycles from TRMM-LIS and OTD (1995-2014)

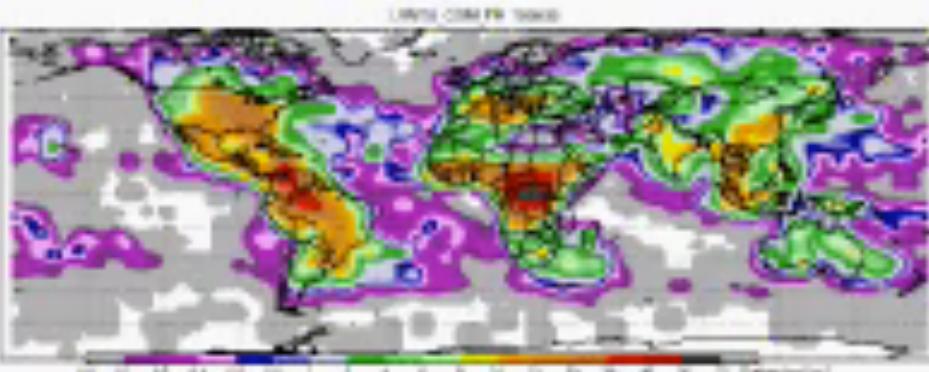


Animation of Diurnal Cycle (in UTC), separately for each month

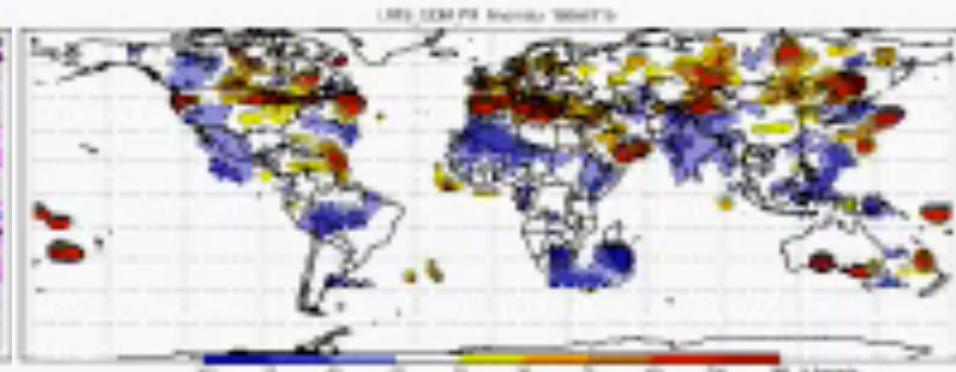
Good data for analyzing this in the tropics already, but ISS-LIS will make characterization of mid-latitudes much more robust

Time Series of Flash Rate from TRMM-LIS and OTD (1995-2014)

Monthly Flash Rate



Percentage Anomaly

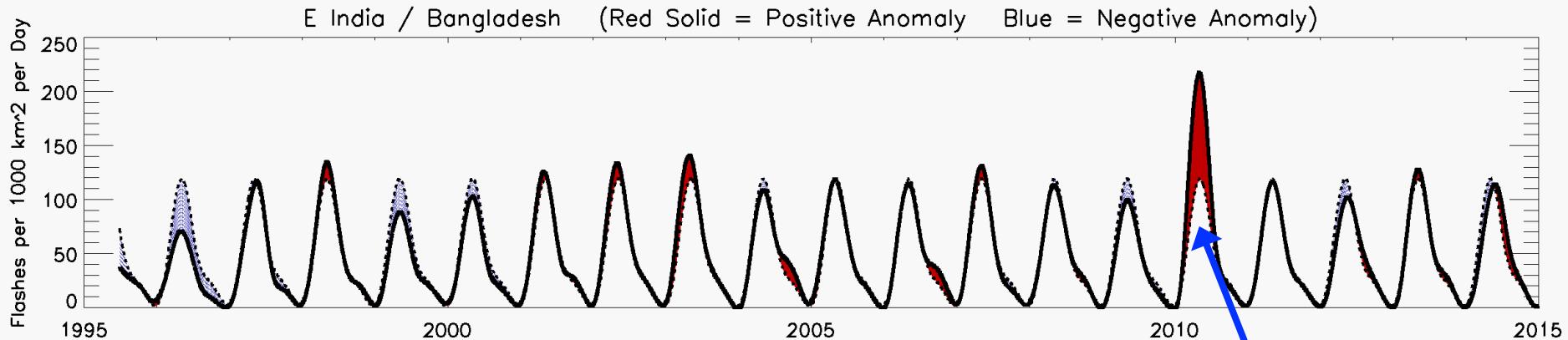


The long record from OTD and TRMM-LIS allows comparisons of different years

Most of the big *percentage* anomalies (at right) are for regions / seasons that do not get much lightning climatologically (e.g., deserts, oceans).

Absolute anomalies can also be plotted, which would highlight only the regions / seasons that do get a lot of lightning.

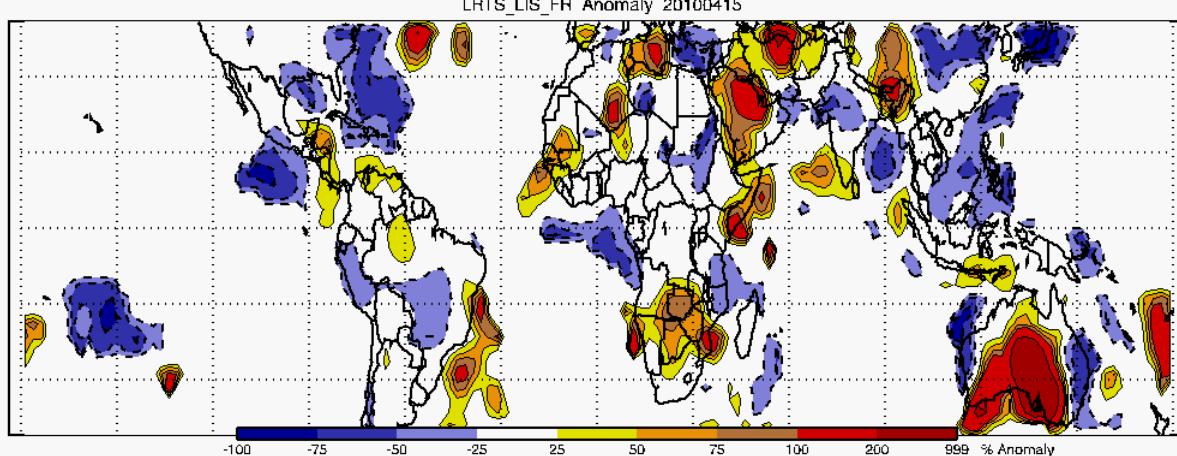
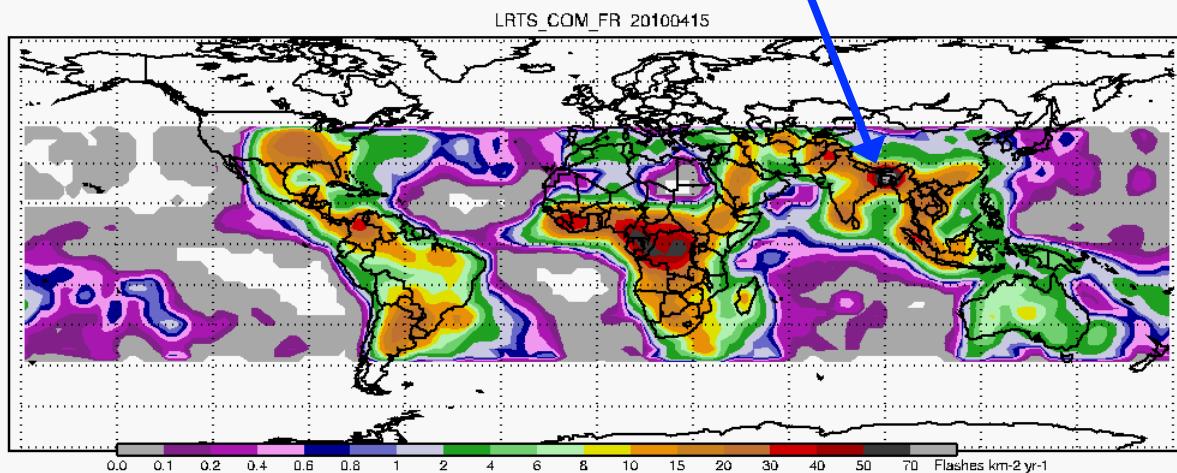
Time Series products have ~3-month temporal smoothing, 7.5° spatial smoothing

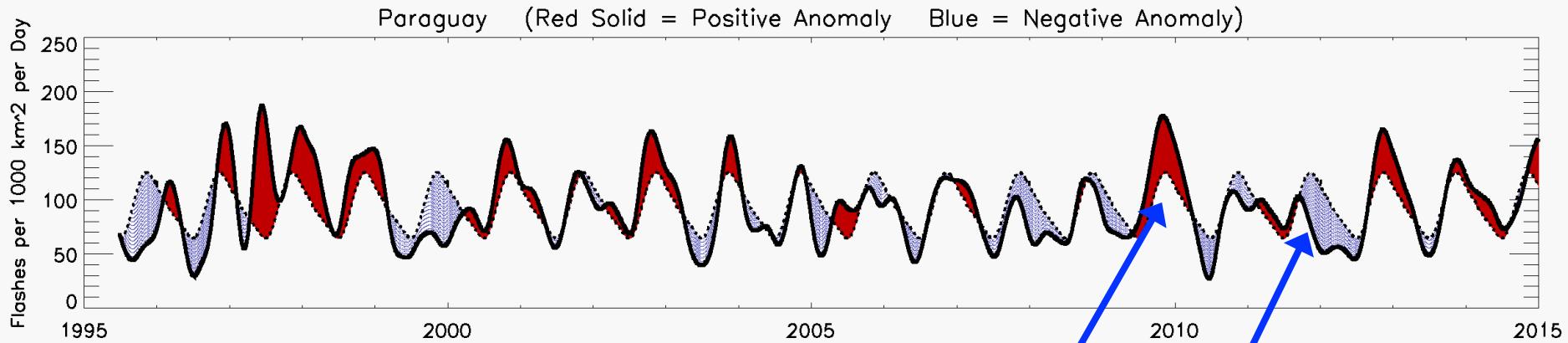


Top: Flash Rate Time Series and Anomalies for a box including **East India and Bangladesh**

For this region, most years are pretty close to normal in terms of total flash rate. 2010 was a huge (positive) anomaly.

Right: Mean flash rate for **March-April-May 2010**, and percentage anomaly from the March-April-May mean

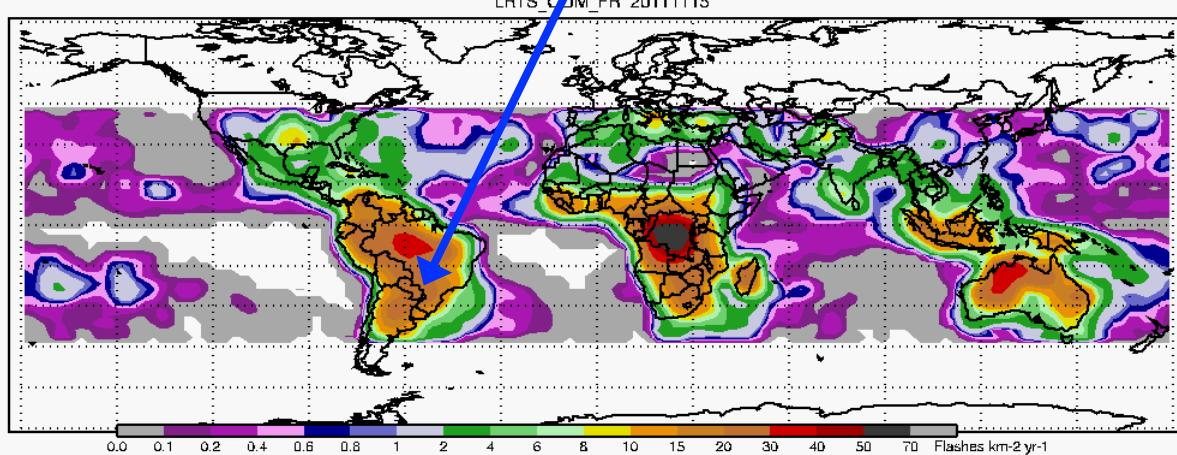
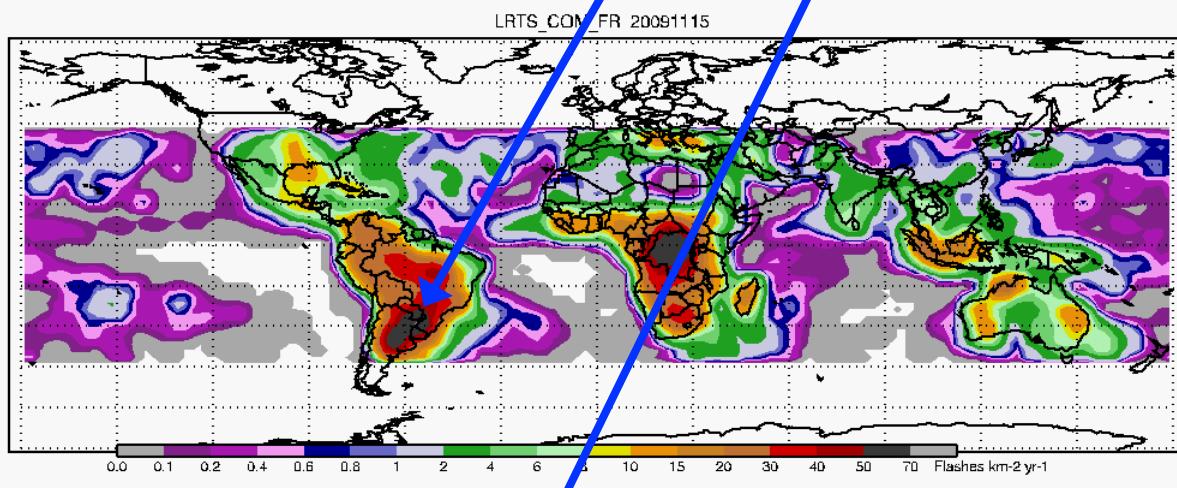


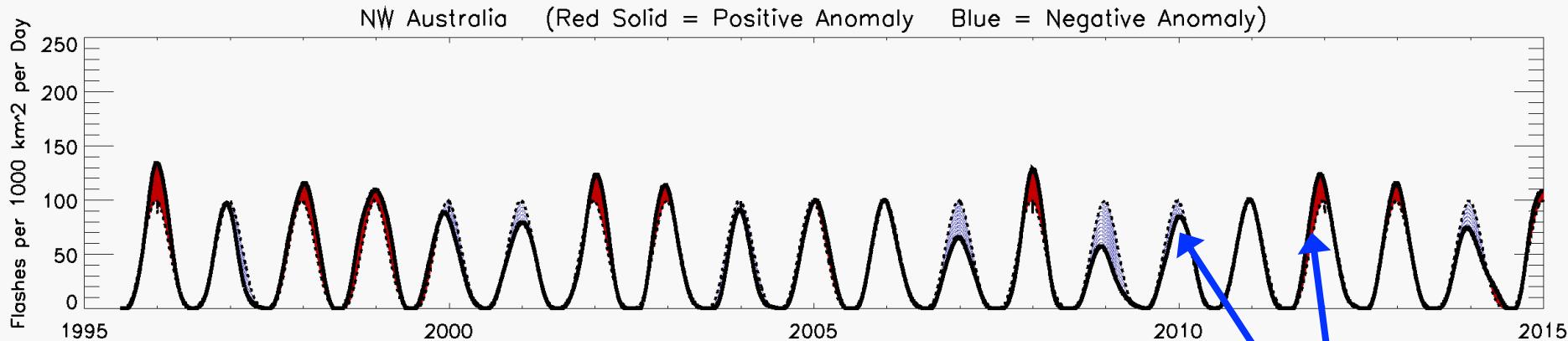


Top: Flash Rate Time Series and Anomalies for a box including **southern Paraguay**

For this region, “normal” almost never happens. Most years are either abnormally active or inactive.

Right: Mean flash rate for Oct-Dec 2009 (top right), and Oct-Dec 2011 (bottom right).

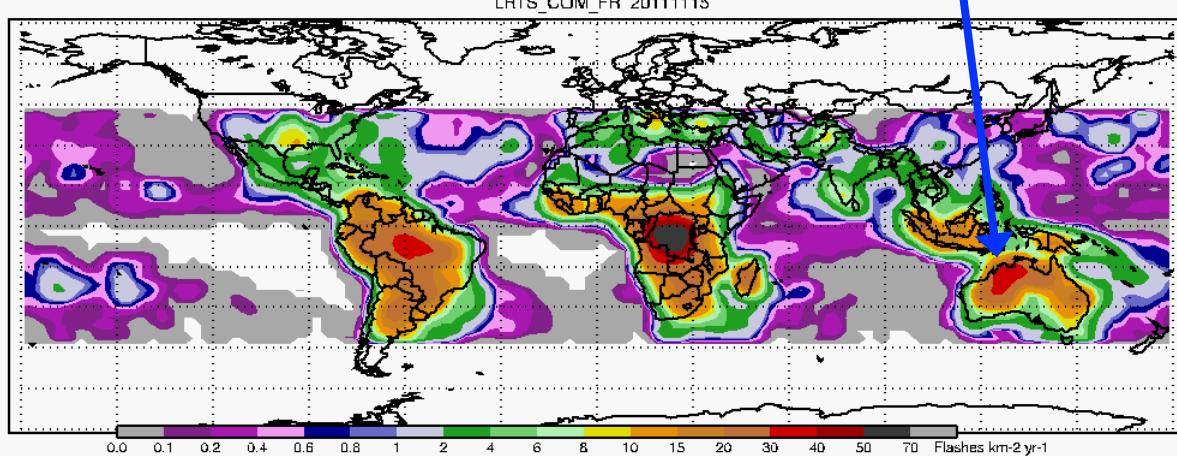
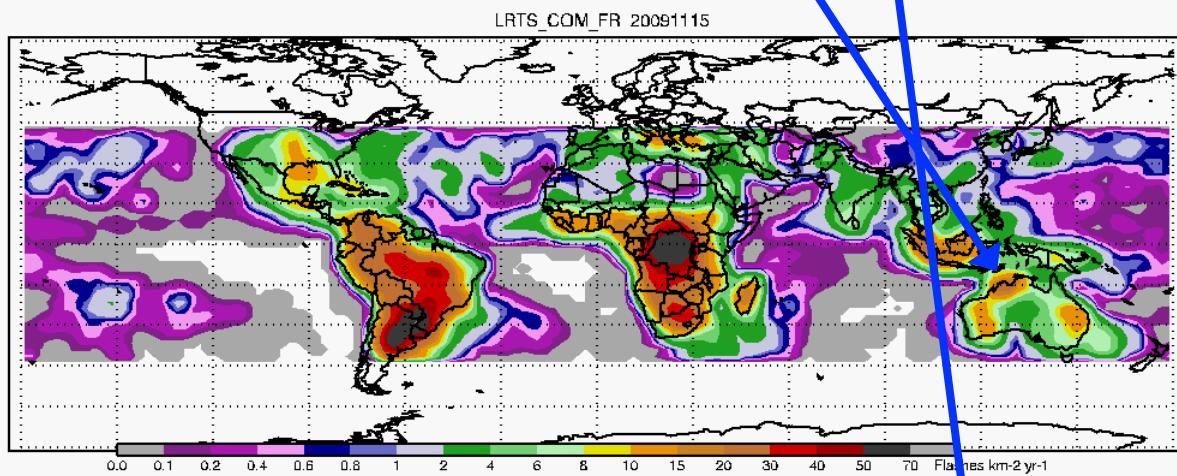




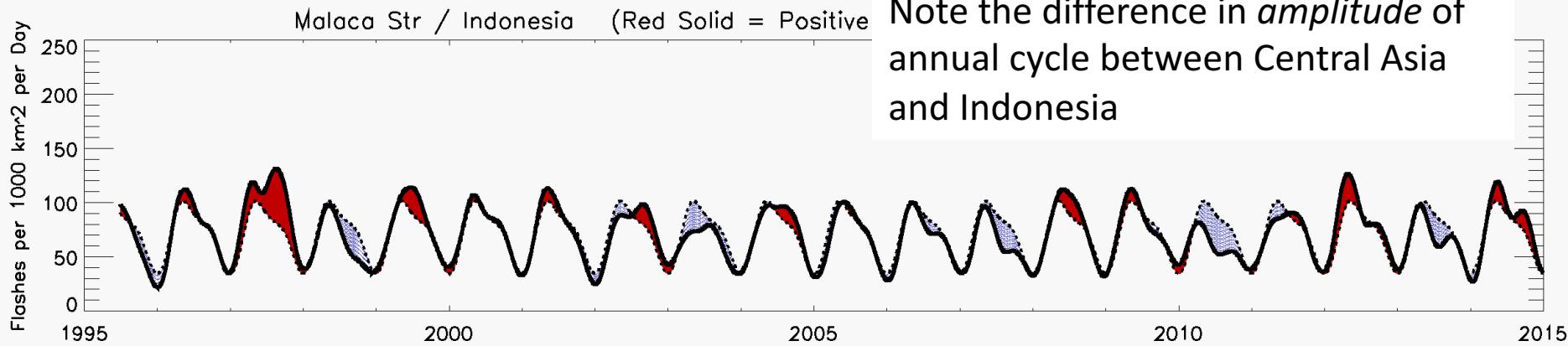
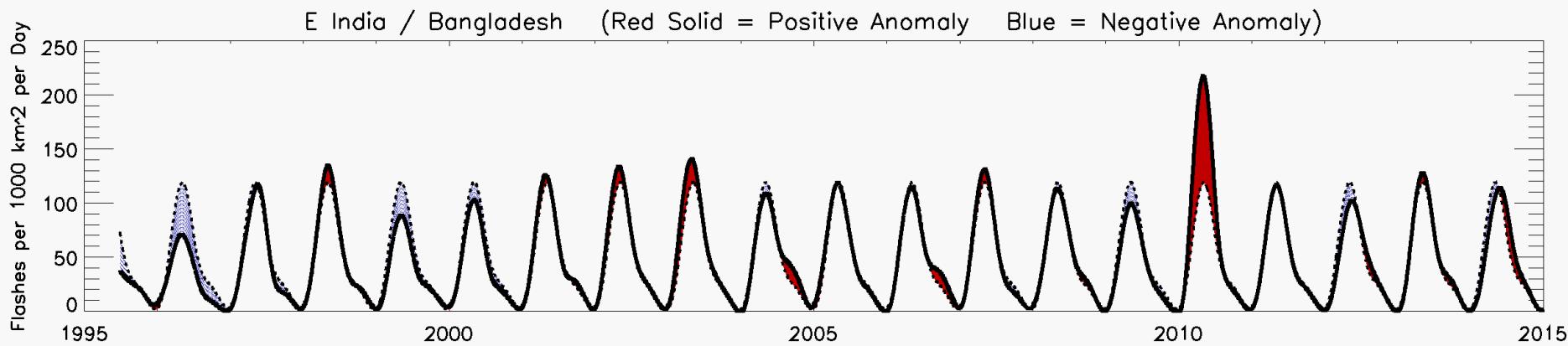
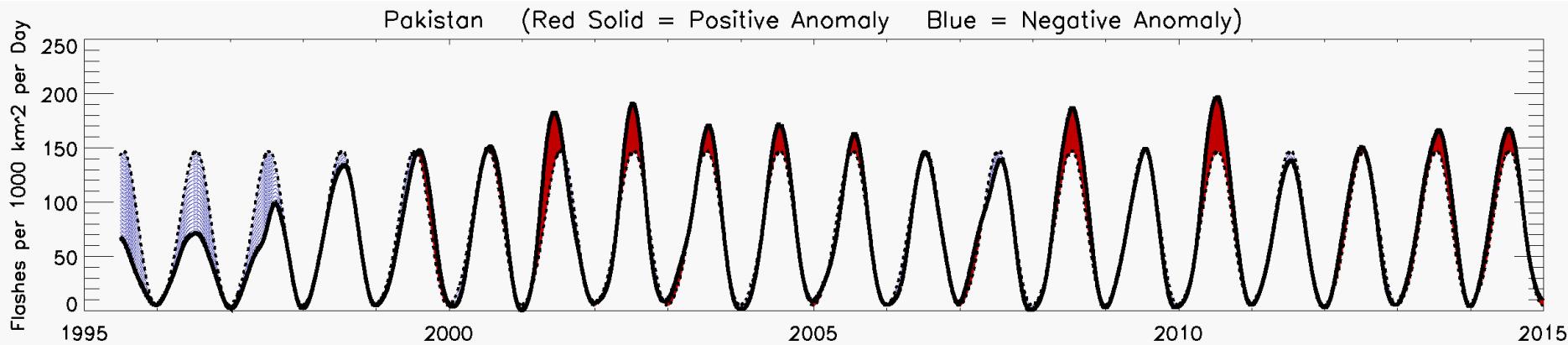
Top: Flash Rate Time Series and Anomalies for a box including **northwestern Australia**

For this region, some years have pretty normal lightning flash rates, some years are particularly active or inactive

Right: Mean flash rate for Oct-Dec 2009 (top right), and Oct-Dec 2011 (bottom right).

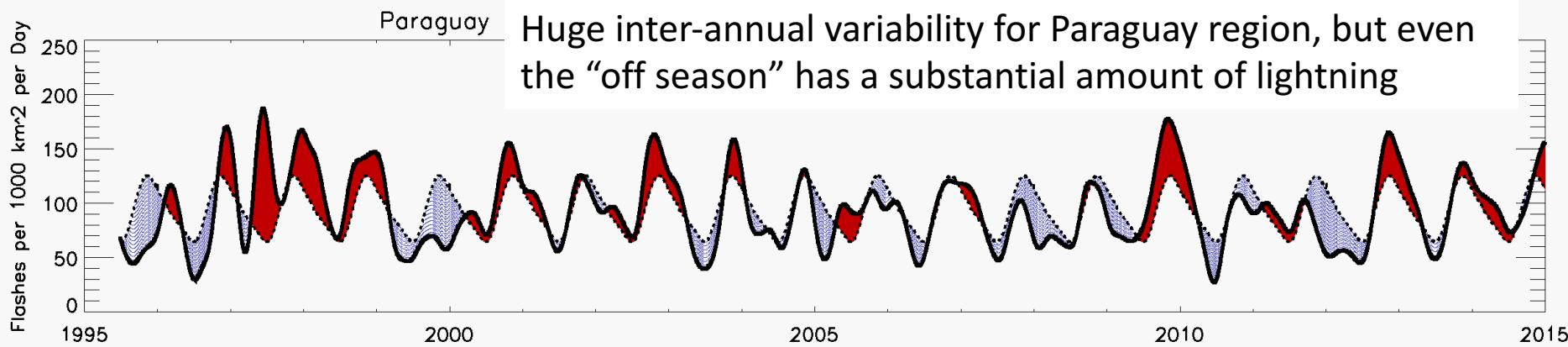
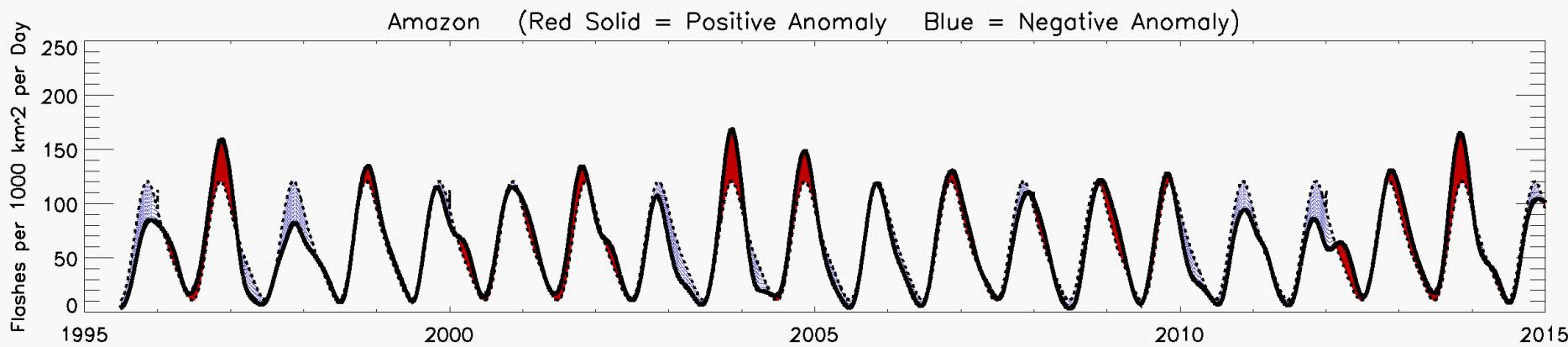
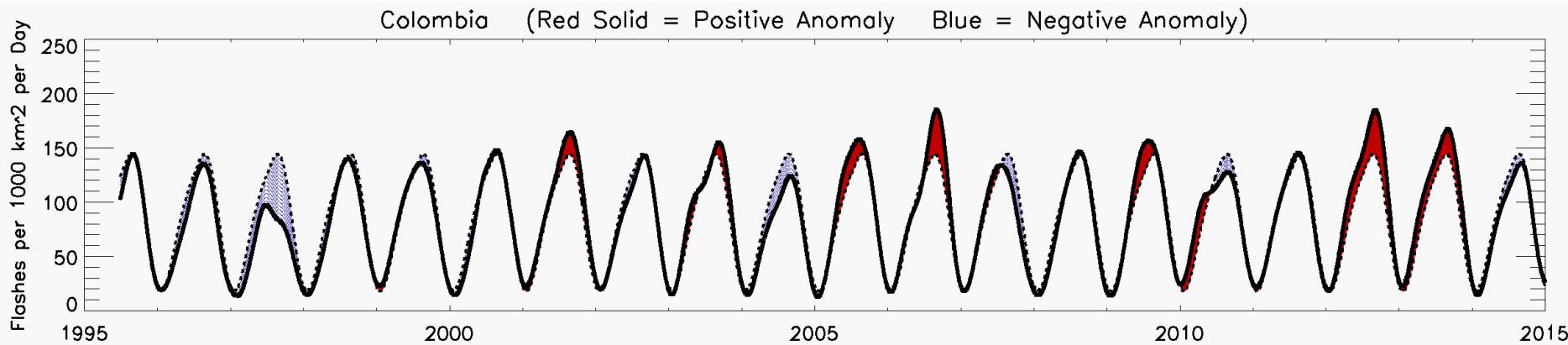


Central Asia and Indonesia

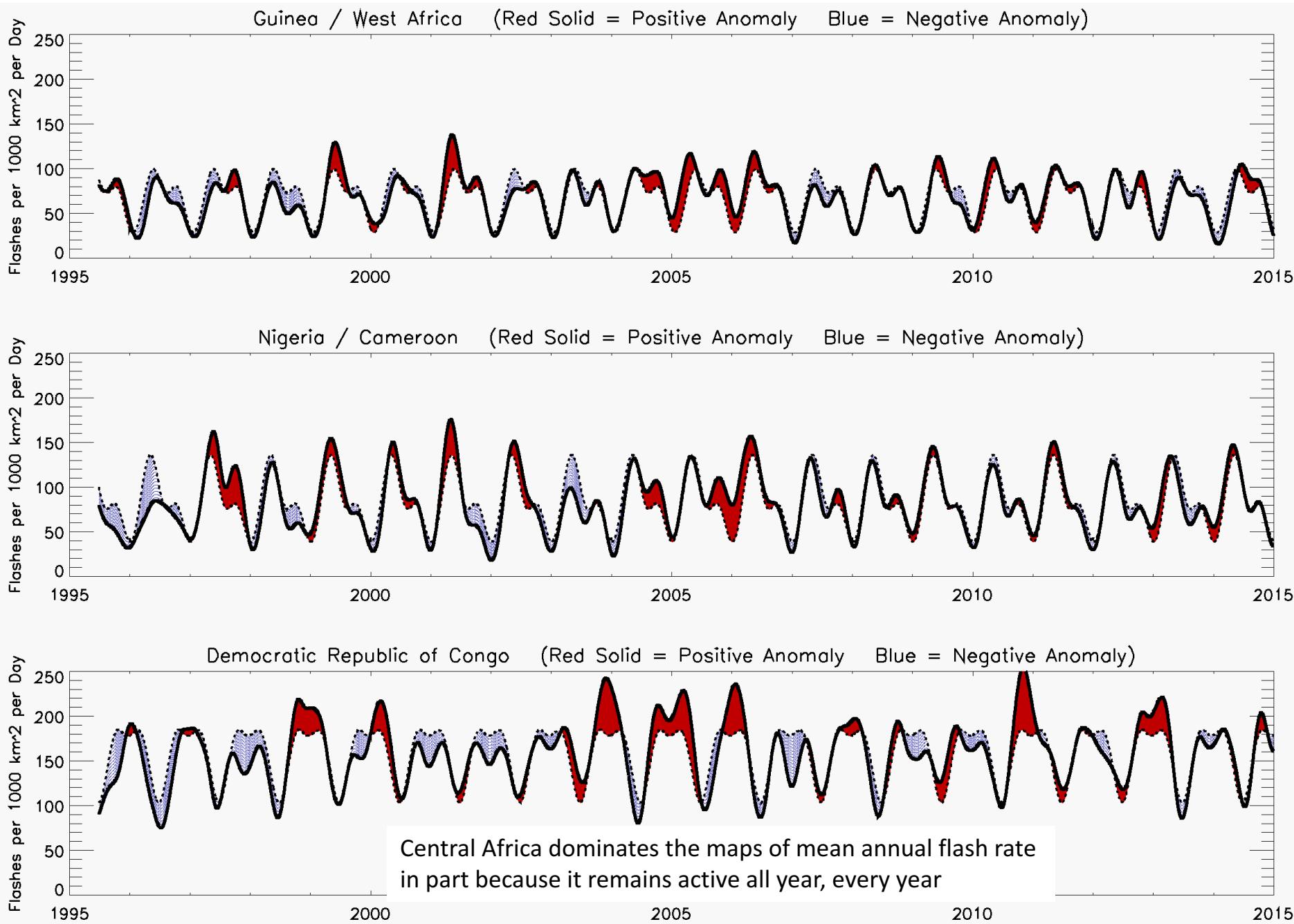


Note the difference in *amplitude* of annual cycle between Central Asia and Indonesia

South America



Africa



Data available from GHRC, pretty easy to use, lots of ways to look at the datasets

https://lightning.nsstc.nasa.gov/data/data_lis-otd-climatology.html

The screenshot shows the GHRC (Global Hydrology Resource Center) website for Lightning & Atmospheric Electricity Research. The main content area displays a global map of Earth with a color scale representing lightning flash rates in $\text{km}^{-2} \text{ yr}^{-1}$, ranging from 0.0 to 70.0. The map highlights high activity in South America, Africa, and parts of Asia. Below the map, there is a "Google Earth" interface. To the left of the map is a sidebar with links to "Lightning Home", "The Lightning Team", "A Lightning Primer", "Dataset Information", "Space Research and Observations", "Field Campaigns and Ground Validation", and "File Cabinet and Bookshelf". A "Global Lightning Image" is also shown. The right side of the page lists "Mean Flash Rate Imagery" options and a section for "LIS/OTD Gridded Lightning Climatology Data Sets". Below this, there are eight entries for different datasets, each with a thumbnail image, a title, a brief description, and an "Animation" link. A "feedback" button is located at the bottom left of the sidebar.

Lightning & Atmospheric Electricity Research

Mean Flash Rate Imagery

- HRFC Annual Mean(0.5°C)
- HRAC Smoothed Day-of-Year Average
- Customize HRAC Day-of-Year Average
- HRMC Monthly Average
- LRFC Annual Mean(0.5°C)
- LRAC Unsmoothed Day-of-Year Average
- Customize LRAC Day-of-Year Average
- LRDC Hourly Average (Diurnal Cycle, Local Time)
- LRTS Daily Time Series (Smoothed)
- Customize LRTS Daily Time Series
- LRMTS Monthly Time Series (Smoothed)
- Customize LRMTS Monthly Time Series
- LRADC 2Hours Daily (Annual+Diurnal Cycle, UTC Time)
- Customize LRADC 2Hours Daily
- LRADC 4Hours Daily (Annual+Diurnal Cycle, UTC Time)
- Customize LRADC 4Hours Daily

LIS/OTD Gridded Lightning Climatology Data Sets

The LIS/OTD Climatology data sets consist of gridded climatologies of total lightning flash rates seen by the spaceborne Optical Transient Detector (OTD) and Lightning Imaging Sensor (LIS).

Documentation:
Gridded lightning climatology from TRMM-LIS and OTD: Dataset description
LIS/OTD Gridded Lightning Climatology Data Sets Guide
LIS/OTD Climatology Product Description Table
LIS/OTD Climatology Data Reader Code
LIS/OTD Climatology Grid Reader Code

Dataset	Description	Animation
High Resolution Full Climatology (HRFC)	Data: LIS/OTD 0.5 Degree High Resolution Full Climatology (HRFC) Browse: HRFC_COM_FR_V2.3.2014.png	HRFC_COM_V2.3.2014.mov
Low Resolution Full Climatology (LRFC)	Data: LIS/OTD 2.5 Degree Low Resolution Full Climatology (LRFC) Browse: LRFC_COM_FR_V2.3.2014.png	LRFC_COM_V2.3.2014.mov
Low Resolution Diurnal Climatology (LRDC)	Data: LIS/OTD 2.5 Degree Low Resolution Diurnal Climatology (LRDC) Animation: LRDC_COM_V2.3.2014.mov	LRDC_COM_V2.3.2014.mov
Low Resolution Annual Diurnal Climatology (LRADC)	Data: LIS/OTD 2.5 Degree Low Resolution Annual Diurnal Climatology (LRADC) Animations: LRADC_COM_SMFR2_V2.3.2014.mov LRADC_COM_SMFR_V2.3.2014.mov	LRADC_COM_V2.3.2014.mov
High Resolution Monthly Climatology (HRMC)	Data: LIS/OTD 0.5 Degree High Resolution Monthly Climatology (HRMC) Animations: HRMC_COM_V2.3.2014.mov HRSC_COM_V2.3.2014.mov	HRMC_COM_V2.3.2014.mov
Low Resolution Monthly Time Series (LRMTS)	Data: LIS/OTD 2.5 Degree Low Resolution Monthly Time Series (LRMTS) Animation: LRMTS_COM_V2.3.2014.mov	LRMTS_COM_V2.3.2014.mov
Low Resolution Annual Climatology (HRAC)	Data: LIS/OTD 0.5 Degree High Resolution Annual Climatology (HRAC) Animation: HRAC_COM_V2.3.2014.mov	HRAC_COM_V2.3.2014.mov
Low Resolution Annual Climatology (LRAC)	Data: LIS/OTD 2.5 Degree Low Resolution Annual Climatology (LRAC) Animation: LRAC_COM_V2.3.2014.mov	LRAC_COM_V2.3.2014.mov
Low Resolution Annual Climatology Time Series (LRACTS)	Data: LIS/OTD 2.5 Degree Low Resolution Annual Climatology Time Series (LRACTS) Animation: LRACTS_COM_V2.3.2014.mov	LRACTS_COM_V2.3.2014.mov
Low Resolution Time Series (LRTS)	Data: LIS/OTD 2.5 Degree Low Resolution Time Series (LRTS) Animations: LRTS_COM_V2.3.2014.mov	LRTS_COM_V2.3.2014.mov
Low Resolution 2.5 Degree Low Resolution Time Series (LR2.5)	Data: LIS/OTD 2.5 Degree Low Resolution Time Series (LR2.5) Animation: LR2.5_COM_V2.3.2014.mov	LR2.5_COM_V2.3.2014.mov